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Comprehensive Livestock Environmental Assessment for Improved Nutrition, a Secured Environment and Sustainable Development along Livestock and Aquaculture Value Chains Project

PGIS Workshops' Summary Reports

24–25 June 2014, Lushoto Highlands Hotel, Lushoto, Tanzania

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STOCKHOLM ENVIRONMENT INSTITUTE
WORKING PAPER NO. 2015-04

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EXECUTIVE SUMMARY

This report describes the results of a multi-stakeholder workshop that was organised in the Tanga region of Tanzania, in order to develop an overview of small-scale dairy systems in the Lushoto and Handeni districts. The workshop focused primarily on livestock keeping, feed production and the support infrastructure and services required for small-scale dairy production, as well as the environmental context supporting the systems. Together, the information provided a basis for discussion of the likely impacts on the environmental context associated with livestock keeping for dairy production. The data were captured using participatory mapping (PGIS, Cinderby et al. 2011, Elwood 2006) in small group discussions during the workshop. These discussions yielded a wealth of relevant information describing the state of dairy production and natural resources in June 2014, for input into the CLEANED-VCs framework (summarised in Table 1) that is especially useful because it was developed by the stakeholders who know and operate within the landscape, and who manage the associated natural resource base through their activities. The results will complement secondary data, household-level information and expert knowledge as inputs into a proof-of-concept implementation of the ex-ante environmental assessment using the Comprehensive Livestock Environmental Assessment for Improved Nutrition, a Secured Environment and Sustainable Development along Livestock and Aquaculture Value Chains (CLEANED-VCs, Lannerstad et al. manuscript). For more information visit the project website at: http://sei-international.org/projects?prid=2057.

Table 1: Summary of the information compiled by participants during the workshop

Livestock system:	Characteristics	Distribution within the district (% of district area in which the system is present)
Intensive	Livestock are kept in their pens all year round; all feed (collected or bought) and water is provided *in situ*. Collected natural fodder and crop residues are chopped and mixed at home, while concentrates are purchased or processed at small mills from one's own or purchased crop residues, e.g. sunflower and cotton (if available). Typical number of cows: 2–10	Lushoto: 50–65% Handeni: <5% (3 locations)
Semi-intensive	Livestock are let out to graze in communal areas during the day and returned to their pens at night; additional feed (collected or bought) is provided in their pens in the dry season and during milking (especially concentrates). Collected feed is collected and brought home to be chopped and mixed; concentrates are purchased or processed at small mills from one's own or purchased crop residues, e.g. sunflower (if available). Typical number of cows: 2–15	Lushoto: 10–30% (depending on groups) Handeni: <5% (4 towns)
Mixed	Livestock are kept extensively in the wet season (let out to graze all the time) and intensively in the dry season (kept in their pens all the time).	Handeni: <5%; 2 locations (Mzundu, Negero)
Extensive	Livestock are let out to graze all year round in communal areas, with no additional feed provided in their pens. Livestock mostly graze natural pastures; after harvest, livestock are allowed on to the fields to graze the residues in return for a small fee (especially in Handeni). Typical number of cows: 20–500+	Lushoto: 20–25% Handeni: 96%

Ranch	Large private areas where livestock graze in a managed system and receive supplementary feed. Ranches are typically for beef production.	1 ranch (Mzeri ranch) located just outside Handeni town
Feed types:	**Species**	**Feed production**
Natural forage	Napier/elephant grass, Guatemala, Mulato/Buffalo grass; legumes, including *Leucaena*; weeds; grazing native grasses	Collected from roadside, verges; grazed
Cultivated forage	Napier/elephant grass, Guatemala, Buffalo grass; legumes including *Leucaena*, *Desmodium*	Grown on contours and field edges (Lushoto), and a few managed pastures (Handeni)
Crop residues	Maize stover, rice and wheat straw, beans, peas, sweet potato	Grazed in-field and/or collected for cows in sheds; rice straw from 2–3 irrigated areas around the edges of Lushoto
Concentrates	Maize bran, rice bran, cottonseed cake, sunflower cake, minerals, molasses	Bought from local agro-dealers, imported from Arusha, Dar (collecting point); molasses from Morogoro; some maize bran and sunflower cake can be made by farmers locally
Management practices:	**Lushoto**	**Handeni**
Soil and water conservation	*Terracing, fanya juu, contour ploughing:* most of the slopes in Lushoto are terraced using *fanya juu,* or at least ploughed along the contours; *Agroforestry:* forage grass and trees are also commonly planted along the contours and edges	No practices were discussed
Soil fertility	*Manure fertilisation:* up to 3t/ha of manure is applied to maize fields once per year; soil fertility is thought to remain good *Inorganic fertilisers:* used by a few farmers in small quantities (100kg/ha/yr)	No practices were discussed
Use of crop residues	Maize plants are left standing in the ground to dry out completely; Residues are used as a significant component of livestock feed, cut and carried back to the farm to chop up for the livestock or grazed in situ; Some farmers burn the residues to clear their fields for planting or leave crop residues to decompose	Livestock are allowed on to the fields to graze the crop residues in return for a small fee; Some residues are processed into concentrates (e.g. sunflower)
Manure management	Manure from the cow sheds is collected and heaped (unprotected) to accumulate for six months before use on the fields, during which time it starts to decompose	Few farmers collect manure to use – either it is discarded, or the kraal is moved; those farmers who do use manure can collect manure from those who do not
Veterinary health	Farmers prefer to spray cattle rather than dip, as they commonly have fewer than 10 cows per household, but the spray kit and acaricides are not always readily available; The government provides a free annual vaccination against Contagious Bovine PleuroPneumonia (CBPP)	Farmers prefer to dip cattle rather than spray, as they commonly have more than 80 cows per herd, dips are maintained by the farmers; The government provides a free annual vaccination against Contagious Bovine PleuroPneumonia (CBPP)

Breeding	Artificial insemination (AI) is less common than the use of bulls; High-yielding improved dairy cattle breeds such as Fresian or Jersey are available, but hybrids with the native Zebu are preferred over pure-breds because they are more hardy – maintaining good quality cross-breeds remains a challenge	Artificial insemination (AI) is less common than the use of bulls; AI has an approximately 20-km reach by road from the equipped towns; High-yielding improved dairy cattle breeds such as Fresian or Jersey are available, but hybrids with the native Zebu are preferred over pure-breds because they are more hardy – maintaining good quality cross-breeds remains a challenge
Key natural resources:	**Status**	**Opportunities and risks**
Land	Field size in Lushoto is considered small but productive; Handeni has extensive communal land	High competition for land in Lushoto – no space for grazing, especially in highland parts; there is more land available in Handeni
Water	In Lushoto, there are permanent rivers; Handeni has seasonal rivers supplemented by dams, wells and rainwater harvesting tanks	Main source of pollution is human settlements and farming activities; most dams in Handeni have troughs for livestock to drink from in order to protect the water quality
Soil	In Lushoto, fertility is maintained by constant manure application; Handeni is still seen as virgin, so there is no perceived need to apply manure	Some areas of Lushoto, where farmers do not use terraces, have more erosion; there are compaction and erosion in Handeni, particularly around watering points and markets
Vegetation	Lushoto generally has enough vegetation year round, due to the high rainfall; Handeni has a shortage of fodder in the dry season	Some areas are 'needlessly' burned in both Lushoto and Handeni, which is seen as a problem for vegetation growth

1. INTRODUCTION

This report describes the results of an assessment of the small-scale dairy production systems in the Morogoro region of Tanzania. The work is part of the ILRI Comprehensive Livestock Environmental Assessment for Improved Nutrition, a Secured Environment and Sustainable Development along Livestock and Aquaculture Value Chains (CLEANED-VCs) project, which contributes to the Maziwa Zaidi project[1] by assessing the impact of dairy interventions on surrounding environmental resources. The Maziwa Zaidi project is working to improve livelihoods by improving milk production now and into the future (ILRI 2014a), and ensuring that it is environmentally, socially and economically sustainable. Short-term improvements in dairy-related livelihoods are less beneficial if the environmental resources cannot sustain them, or if other livelihood activities are negatively affected by environmental degradation.

1.1 Assessment workshop process

The assessment, conducted in a workshop in June 2014, aimed to obtain a geographic representation of dairy production and the interacting environmental elements in the study area. This was achieved by asking local experts to describe, by mapping, the dairy livestock and feed production systems in operation across the district, and to assess the distribution of production in relation to the resources available. The workshop focused on Maziwa Zaidi sites in the Lushoto and Handeni districts of the Tanga region (Figure 1).[2] Lushoto and Handeni are very different districts – and opposite in many respects. Lushoto is a mountainous area 1200–1900m above sea level (Google Earth), with a high mean annual rainfall (800–1400mm, ILRI 2007), a relatively high human population and intensive farming practices. Most of the district is steeply sloping. Handeni, on the other hand, is in the lowlands, 500–900m above sea level, and much drier, with a mean annual rainfall of 600–800mm. It has a low human population and extensive farming activities. The variability across the study area means that it is not always possible to generalise across the two locations. Where necessary, this report refers to each in turn.

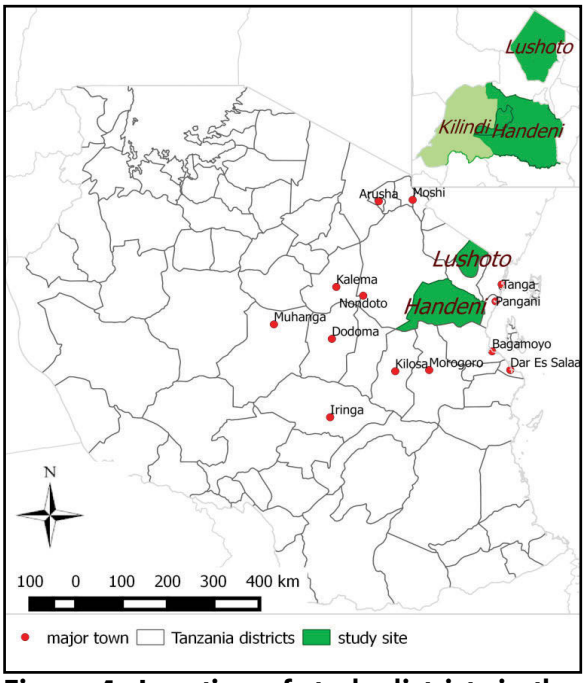

Figure 1: Location of study districts in the Tanga Region of Tanzania

Note: Inset shows the most recent district boundaries, as of 2012 (Data source: FAO Geonetwork, National Statistics Agency Tanzania)

In addition, the experts explored several scenarios for interventions to alter the production systems and discussed the associated environmental impacts. Participating experts came from the Lushoto and Handeni districts (Table 2). Participants represented a number of different stakeholder groups: chairpersons of dairy farmer groups, input and service providers, local government extension officers and milk traders/vendors.

1 http://moremilkit.wikispaces.com/home

2 The boundaries used in the workshop's base map (Figure 1) were found to be out of date. The inset shows the correct, current boundaries, which are used throughout this report.

Table 2: Organisations and actors represented at the workshop

Organisation/occupation	Male participants	Female participants	Total participants
Total:	19	3	22
District Livestock Officer	5	0	5
District Crop Officer	1	0	1
District Agricultural Officer	1	0	1
Forester	1	0	1
Chairperson of dairy farmer group	4	0	4
Farmer/ livestock keeper	1	0	1
Milk collector[a] or collection point agent	3	1	4
Input provider	1	0	1
Milk processor representative	2	2	4

[a] Milk traders/vendors who collect and buy fresh milk from farmers and sell it either locally or to milk collection centres and other outlets.

1.2 Methodology

The data were gathered using Participatory GIS workshops, an approach whereby a number of structured discussions are carried out and the resulting information is mapped by the local stakeholders. This ensures that the knowledge produced is rooted in the participants' understanding within a spatially explicit framework (Cinderby et al. 2011, Elwood 2006). A technical description of how to conduct a Participatory GIS workshop is presented in TBD (2015).

The expert workshop was held over two days, and included several PGIS sessions. The discussions focused on the following topics:

- the common categories of **dairy livestock keeping** and **feed production**;
- landscape **environmental resources**; and
- **scenarios for dairy development**.

The expert conversations were carried out mainly in Swahili, with some translation to and from English where necessary. The expert conversations were documented primarily in the maps drawn by the participants, complemented by notes taken on flipcharts. The mapping was conducted by drawing with permanent coloured markers on layers of acetate (transparent plastic sheets), which were fixed over the base map of district boundaries, roads, rivers, key towns and landcover (Figure 2). This method allowed several new maps to be drawn over the base map, showing the features from the different discussions, with each new set of features on a fresh acetate sheet. The acetates were blank, except for the major road network and towns for use as georeference points so that they could be digitised using GIS-based software and geo-referenced to the basemap after the workshop (see section 1.3 Information processing).

Tanzania's administrative boundaries were changed in the 2012 census, dividing the regions into new districts. Therefore, the base maps, which used FAO Geonetwork boundaries from 2002, were out of date. The town and road layers were also inaccurate, with some towns or roads either incorrectly placed or missing. As a result, some time was spent initially in correcting the faults and errors in the maps before the mapping of livestock keeping and feed production could begin.

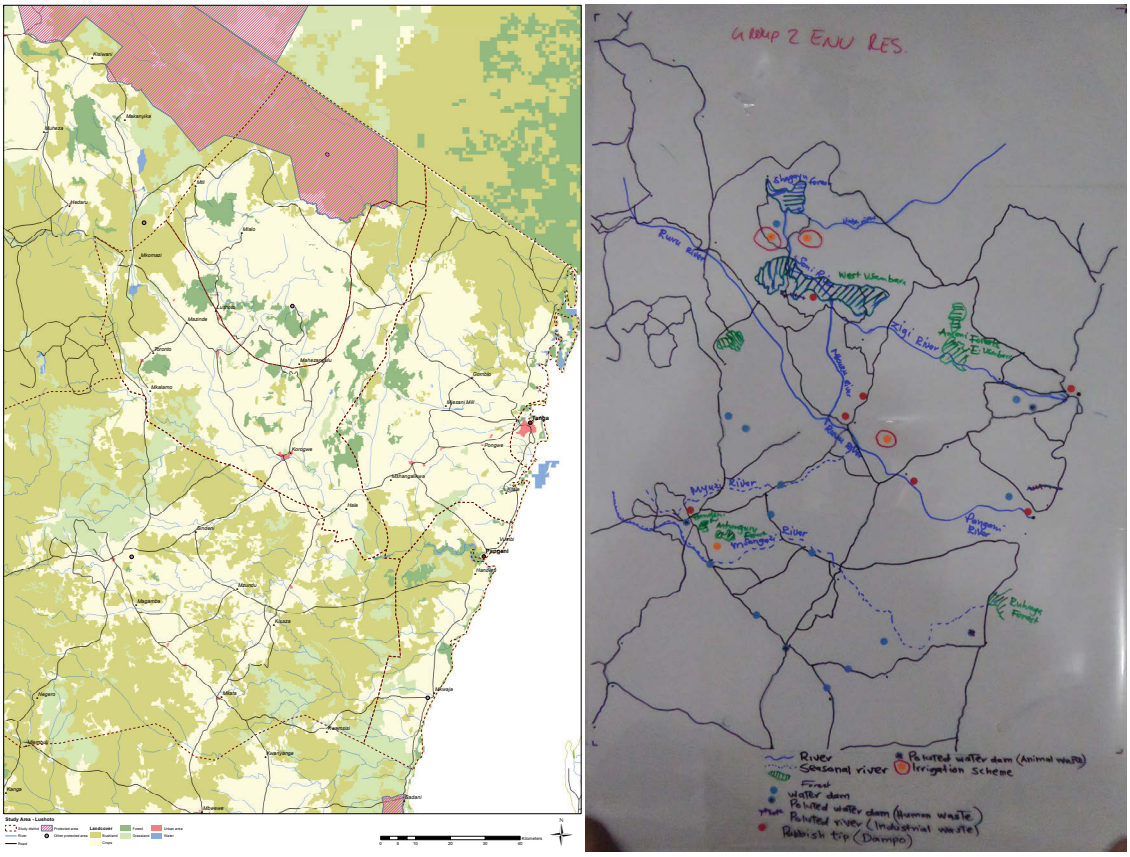

Figure 2: Base map used in the workshop, with Lushoto and Handeni districts, roads, towns and landcover (left) and an example of participants' mapping on to an acetate that would have been affixed over the base map

(Data sources: Valuing the Arc landcover Swetnam et al 2011; districts, roads, towns, FAOGeonetwork).

Some participants struggled to locate areas they knew because the map did not have the right information. Although the Tanga, Muheza, Pangani and Korogwe districts were included in the base map, participants did not feel confident enough in their knowledge of these districts to describe their dairy production accurately. Therefore, blank areas on the map at Tanga and Korogwe districts indicate 'no data' rather than 'no livestock farming'. Lushoto and Handeni districts were covered comprehensively. When describing the distribution of livestock systems, for example, the participants identified areas in both Handeni and Lushoto by village or ward.

All the proceedings were recorded and subsequently transcribed and translated into English. All the notes written on flipcharts, and the maps drawn on acetates by the participants were photographed at the end of each day. This workshop report reflects the voices of the participants, unless otherwise stated, and is based on the English transcriptions, flipchart notes, digitised maps and team reflections. This methodology is shown in Figure 3.

Following the workshop, the team participated in field visits in both Lushoto and Handeni led by the local livestock officer for each district, visiting milk collection points, examples of intensive and semi-intensive dairy keeping, a small reservoir, feed and milk processing, retail feed and drug stores, veterinary clinics and a demonstration fodder production plot.

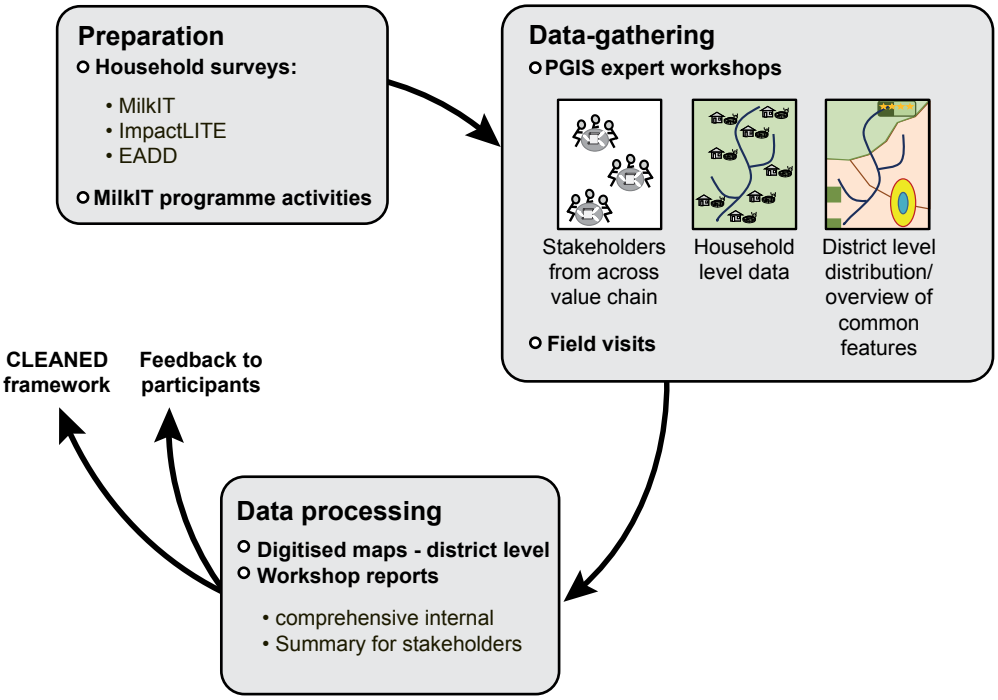

Figure 3: Process of data gathering for the CLEANED framework

Preparation, participatory GIS sessions and data processing

1.2.1 Preparation

Prior to the workshops, key literature and data sources on the study area were reviewed, including village-level data and household-level data. The household data were collected in earlier surveys of over 1000 households across the Morogoro and Tanga regions of Tanzania (Silvestri et al. 2014, ILRI 2014b; Fraval et al. 2013). The surveys collected information on dairy production and feed crop production, such as herd size, milk yield, fodder types and ratios, and fertiliser use in crop production. Selected summary statistics derived from the data collected (Table 3) were used to inform initial descriptions of common types of dairy livestock keeping in the study area, in comparison to the wider region.

Table 3: Production system traits in Tanzania nationally, and by region/district
Data source: ImpactLite dataset, ILRI/CCAFS 2012; MoreMilkiT baseline, CGIAR, 2013; Dairy in western highlands of Kenya, ILRI, 2013.

Dairy farm characteristics	Eldoret, Kenya Mean/max (n)	Tanzania[c] Mean/max (n)	Lushoto Mean/ max (n)	Handeni Mean/ max (n)
Herd size	8/47 (n=194)	43/678[a] (n=818)	4/24 (n=290)	48/520[a] (n=250)
Exotic cattle (% of herd)	9/100 (n=194)	34/ 100 (n=818)	77/100 (n=270)	5/100 (n=250)
Land size (ha)	3/36 (n=194)	16/1000 (n=818)	2/14 (n=290)	19/233 (n=250)
Average milk yield (annual)[b]	1818/6620 (n=194)	433/2950 (n=515)	752/2950 (n=102)	313/2464 (n=197)
Concentrates fed (kg per animal, annual)	349/3345 (n=194)	115/3600[a] (n=814)	166/1920 (n=287)	46/1800[a] (n=249)
Feed Crop residue (%)	88	58	83	46
Feed fodder (%)	73	21	58	0
Purchased feed (%)	54	10	25	1

[a] Outlier removed, for example where data were deemed inconsistent with the context
[b] Annual milk yield estimated using milk at calving and 'yesterday's yield', averaged over the milking herd
[c] Tanzania limited to Lushoto, Handeni, Mvomero and Kilosa

Secondary studies also provided valuable insights into the study area, including: FEAST reports (Wassena et al. 2013a,b; Mangesho et al. 2013), village-level assessments and peer-reviewed studies (Wickama et al. 2014).

1.3 Information processing

The maps were digitised into Q-GIS (open-source GIS software, www.qgis.org) by first geo-referencing the photographs of the map layers drawn by participants and then tracing and classifying the features on to individual layers in the digital database. Initial analysis of the data included synthesising maps on the same topic drawn by different groups, and merging the information into single layers. Conflicts in the data drawn were resolved based on the transcripts of plenary discussions, the notes of individual group discussions and discussion within the team where necessary. In general, if the points were in quite close proximity (i.e. the same town), they were merged. Otherwise, all points were kept separate.

2. SMALL-SCALE DAIRY PRODUCTION IN LUSHOTO AND HANDENI

2.1 Distribution of dairy farming: milk production systems

Participants categorised livestock keeping into four broad categories:

- *Intensive (zero-grazing)*: where animals are housed under controlled conditions, and are never let out of the pens. All fodder is collected (cut and carry) or bought: collected fodder is chopped and mixed at home, concentrates are purchased or processed at small mills from own grown or purchased residues, e.g. sunflower (if available). The most common fodders are Napier grass (also known as Elephant grass), and Mulato (Buffalo grass, *Cenchrus ciliaris*), grass from mixed pastures, rice straws, maize stover, beans and concentrates.

- *Semi-intensive*: where animals are let out to graze during the day and returned to their pens at night; animals are given additional feed in the dry season and during milking (especially concentrates); additional feed is collected and brought home to be chopped and mixed; concentrates are purchased or processed at small mills from own grown or bought residues, e.g. sunflower (if available).

- *Extensive, pastoralism (all grazing)*: where animals only get feed by grazing outside their pens, in communal areas. Livestock may graze natural pasture locally, but may also be taken long distances from home in nomadic herding, which falls within the extensive category. After the harvest, livestock are allowed on to the harvested fields to graze residues in return for a small fee (especially in Handeni).

- *Ranching*: where livestock are kept semi-intensively with controlled grazing and supplementary feeding. Ranches are private farms, owned by individuals or collectives, larger in size than the average crop holding. The ranchers grow their own fodder and make hay, often enough to sell the excess to other farmers. Ranches are typically for beef production. Two ranches were identified: Mzeri and Nerwa, but the location of Nerwa could not be ascertained.

In Lushoto, it was found that more than half of all livestock keeping is intensive zero-grazing, which takes place in the highlands (Figure 4). Farmers have 2–5 cows on average, and receive 3–5 litres/cow/day of milk on average up to a maximum yield of 8–10 litres/cow/day. Zero-grazing was mainly known of in the townships and villages where farmers work and keep a few animals for milk production. The following locations were identified for zero-grazing in the Lushoto ward: Lushoto, Ubiri, Ngulwi, Kwemashai, Gare, Kwai, Lukozi, Malindi, Shume, Mahoro, Rangwi, Sunga, Mtae, Mwangoi, Dule M, Mlalo, Kwemshasha, Hemtoye, Ngwero, Kwekanga, Malibwi, Mbuzii, Soni, Mamba, Bumbuli, Mgwashi, Boga and Mponde. Livestock keeping in the lowland part of Lushoto was identified as extensive (e.g. Mnazi, Miharo, Mungalo, Lunguzo, Mlola, Makanya and Milingano areas), with semi-intensive management areas on the eastern foothills. Semi-intensive dairy farming was said to be commonly practiced in parts of Vuga, Tomota, Mahezangulu and Mbaramo in Lushoto ward. Two alternate extents were provided for the area in which semi-intensive livestock keeping occurs in the eastern part of the district (see Figure 4); the larger extent is indicated as ‘maybe also semi-intensive’.

In Handeni, by contrast, it was agreed that most livestock keeping was extensive grazing only, with larger herds of 80 up to more than 500 cows per household (Figure 5). Extensive grazing was identified in the Kang’ata, Kwaluguru, Kiva, Sindeni, Ndolwa, Kwamatuku, Segera, Kabuku, Kwamsisi, Kwasunga, Mkata, Mazingara, Kwamkonje, Kwachaga, Misima and Kwamgwe areas. Zero-grazing with fewer cows was identified around settlements, but still very localised to Handeni, Kibuku and Chanika. Semi-intensive livestock systems were located in Magamba/Sindeni,

Handeni town, Mkata, Kidereko and Vibaoni. The average milk yield in Handeni district was estimated to be 2–3 litres/cow/day, with the highest yielding farmers achieving 5–8 litres/cow/day.

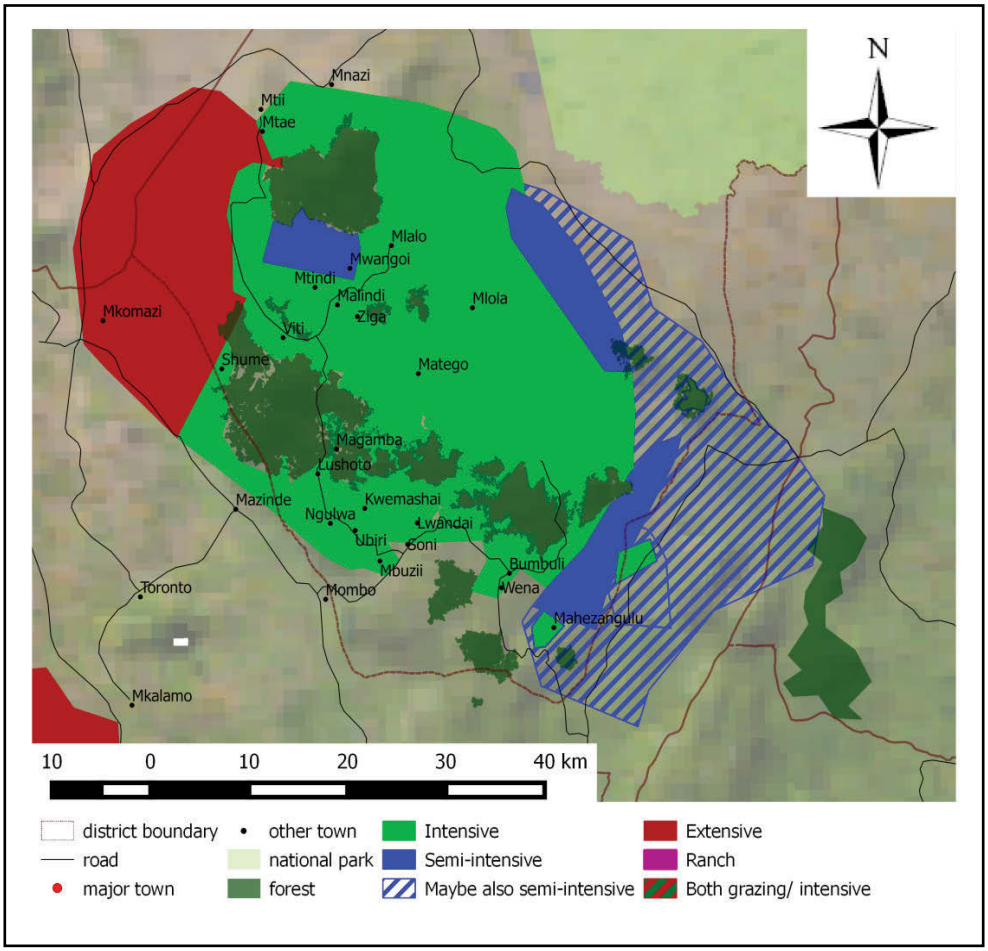

Figure 4: Dairy livestock systems in Lushoto district

Source: expert consultation discussions and PGIS maps, June 2014.

Note: Blank areas on the map indicate 'no data' rather than 'no dairy-related activities'.

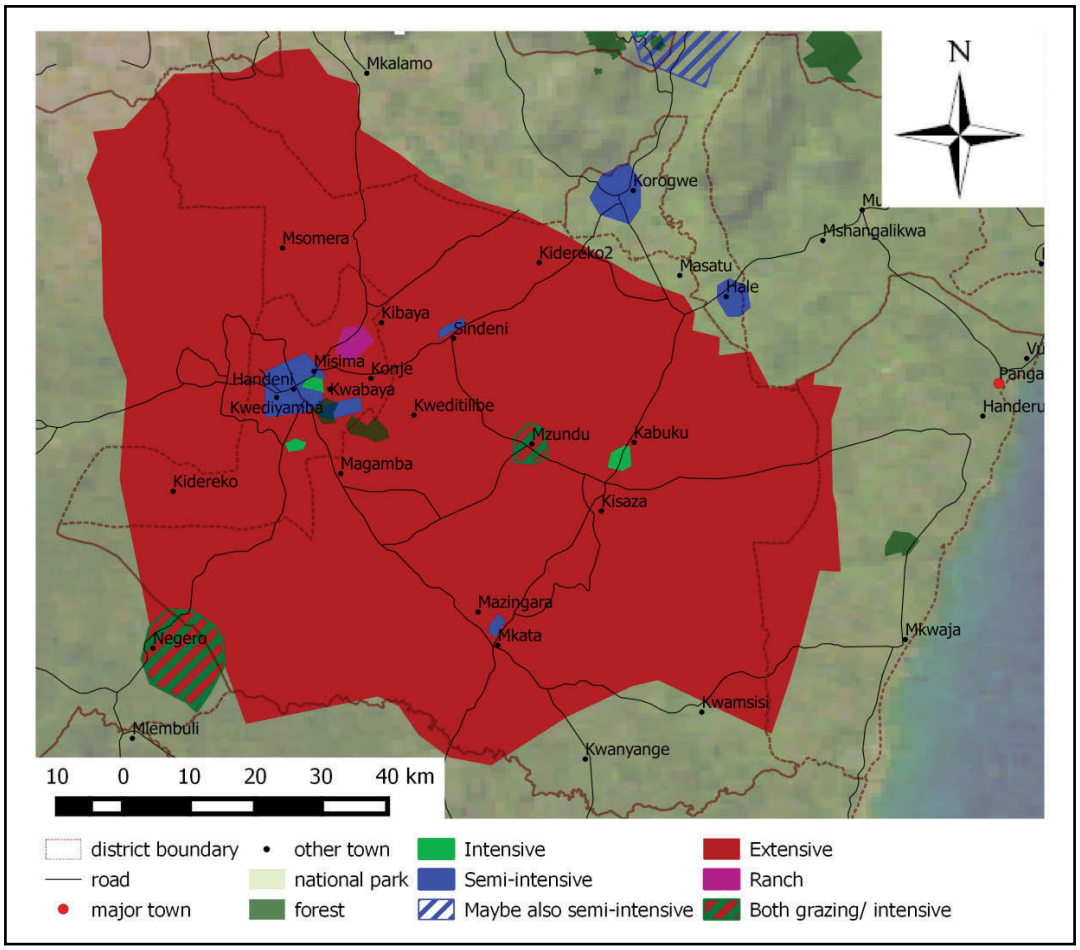

Figure 5: Dairy livestock systems in Handeni district

Source: expert consultation discussions and PGIS maps, June 2014.

Note: Blank areas on the map indicate 'no data' rather than 'no dairy-related activities'.

Manure management

In Lushoto, participants agreed that manure from cow sheds in the intensive and semi-intensive systems is stored on-site, and allowed to accumulate for 6 months until needed for the fields, during which time it partly decomposes. All the manure is used either by the livestock keepers themselves, or on the fields by other farmers. No protective covering or base was thought to be commonly used, but the potential for nutrients to be lost when it rains was not thought to be a problem by participants.

In Handeni, participants noted that manure is removed from the kraals (cattle enclosures) or cow sheds, but that only a few farmers use manure on their fields. Such farmers were able to collect unwanted manure from other farmers. It was noted that biogas has been introduced by a limited number of semi-intensive and zero-grazing farmers in Handeni town.

Other Value Chain components

Among the components of livestock industry infrastructure identified were: milk marketing channels, livestock markets, cattle dips, veterinary health centres and input suppliers (see Table 4 and Figure 6).

Table 4: Infrastructure available in the Lushoto and Handeni districts

	Inputs		Animal health		Outputs		Support
	Livestock markets	Agrovet/ feed supplier	Veterinary health centres	Cattle dips	Milk marketing	Milk processors (small-scale)	Agricultural extension offices
Lushoto	1	Many / Unknown	9	7	4 with cooling 1 no cooling	4	8
Handeni	4	Many / Unknown	5	17	2 with cooling 3 pending	1	8

Farm inputs and agro veterinary centres, where livestock farmers can buy inputs and receive veterinary services, were mapped in almost every centre, and in most cases these areas also had a higher accumulation of livestock farmers.

Farmers generally consume milk at home as fresh or sour, and sell the surplus supply. Milk marketing channels in Lushoto and Handeni include collection centres, cooling facilities, micro-processors and large-scale processors. Tanga Fresh is the major milk buyer in the area, located in Tanga town. Opinion among the farmers represented was that the prices paid by Tanga Fresh were not favourable. Thus, farmers also sold milk locally to vendors, restaurants and individuals.

Five milk collection centres were identified in Lushoto (Bumbuli, Lushoto, Mwangoi, Shume and Mlalo). All had cooling tanks installed except Bumbuli, which sends its milk to the Lushoto cooling point. In contrast, only two cooling points were identified in the Handeni area (Handeni town and Mzeri ranch). Another four are planned as of June 2014: Kwasungu, which is under construction; Kabuku and Kwamsisi have been constructed but are not yet operational; and Sindeni.

Participants noted that only morning milk was delivered to the collection centres, either individually by farmers or by milk collectors who can collect up to 200 litres per day from 20 or more farmers. The milk would either be sold locally, or collected by Tanga Fresh every 2–3 days. Tanga Fresh processes 60 000 litres per day in the wet season, from collection points across the Tanga region as well as a few in the Morogoro region. Tanga Fresh also produces yoghurt and butter, and excess milk is processed into Mozarella. A few smaller processors were identified in Lushoto: a small cheese-making plant in Lushoto town, Montessori centre; Irente farm; Kifungilo; and Sakarani, as well as one in Handeni at the Mzeri ranch.

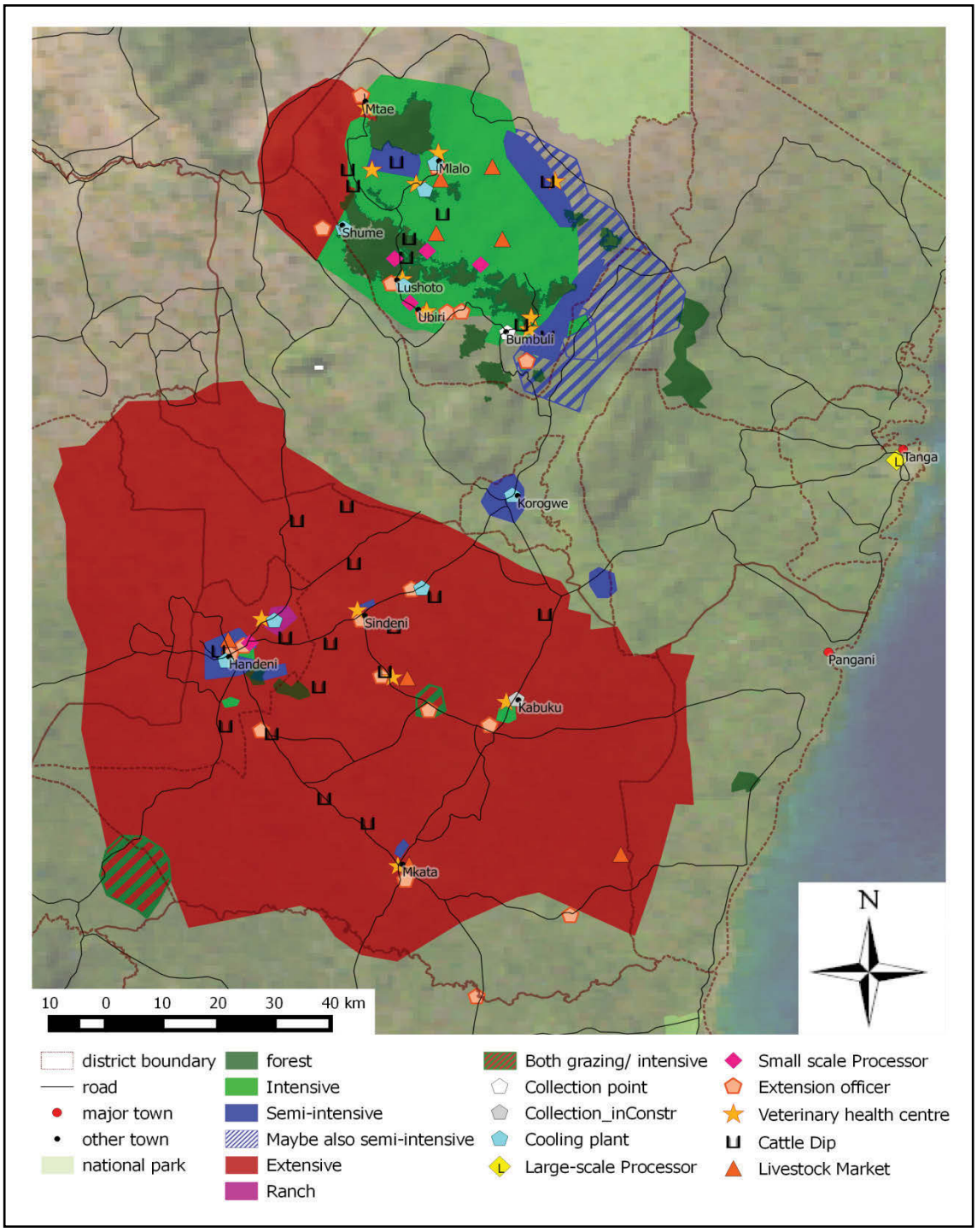

Figure 6 : Support services for livestock systems

Source: expert consultation discussions and PGIS maps, June 2014.

Note: Blank areas on the map indicate 'no data', rather than 'no dairy-related activities'.

During the dry season(s), some livestock keepers were said to migrate further away from urban centres. This migration pattern would present challenges for marketing milk, as farmers would have to travel longer distances to access markets. It was noted that this challenge would be exacerbated by the fact that milk collection centres shut down in the dry season, when the scarce supply makes it unviable to keep the cooling plants running. Although the higher prices received at this time can, in part, act to incentivise the long distance delivery of milk, it was perceived to be uneconomic for many milk producers.

2.2 Distribution of dairy farming: feed production systems

It was agreed that most of the feed in the study area was either grazed or collected rather than purchased. The main sources are natural and planted forages (grasses, legumes and weeds), crop residues, and commercial feeds and concentrates. A summary of common feed sources is given in Table 5, and their locations shown in Figure 7.

Table 5: Common feed types and sources for dairy livestock

Feeds used	Source	Category of livestock keeping that uses it
Natural grass pastures Some forest grazing	All wards, free areas, mostly Handeni	Extensive, semi-intensive
Crop residues: Maize, wheat and rice straw, beans, peas, sweet potato	In Lushoto: livestock keepers collect residues from fields to take to livestock; In Handeni: livestock are allowed into farmers' fields to graze the residues for a small fee	Extensive, semi-intensive, Intensive
Collected natural fodder: Grass, legumes and other weeds	Roadsides, natural vegetation	Semi-intensive, Intensive
Grown fodder grass: Napier/ Elephant grass *(Pennisetum purpureum)*, Guatemala grass *(Tripsacum andersonii)*, Mulato/Buffalo grass *(Cenchrus ciliaris)*, hay *Grown fodder legumes:* Main legumes include *Leucaena,* lucerne, beans, cow peas and crop residues	Agricultural fields – typically grown along contours and field edges in Lushoto; a few managed pastures in Handeni. Hay produced in a few select areas in Lushoto (see map) and on Mzeri ranch (also sold locally) in Handeni	Semi-intensive, Intensive
Concentrates: Maize bran, maize germ, sunflower cake, sorghum cake, rice bran, leucaena concentrate, cotton cake	Processing mills, input dealers (stock from Dar es Salaam or Arusha)	Semi-intensive, intensive

Forage: natural grasses and weeds are collected from common areas, such as roadsides. In Lushoto, farmers are known to plant forage grasses and legumes, such as Napier grass (elephant grass, *Pennisetum purpureum*) and *Leucaena*, on the contours and edges of fields. Fodder trees (agroforestry) are also grown on the edges of farm fields (Huzini, Kunguli, Mlalo, Shume). However, few cases were identified in Lushoto of fields dedicated to cultivated forage for immediate use, hay making or silage, while planted forage is rarely found in Handeni, which the group saw as a 'worrying trend'. Hay is grown in certain parts of Lushoto. In Handeni, the largest hay producer is the Mzeri ranch, where it is grown for use on the ranch and to sell to farmers in the region. Supplementary hay is also bought from neighbouring districts. At Ubiri, a demonstration plot of Napier intercropped with *Desmodium* has recently been grown to encourage the spread of cultivated forages.

The storage of hay is a concern. All the participants agreed that forage preservation is needed to improve feed supply in the dry season, but that hay is likely to rot in the damp conditions in Lushoto, or to be infested with insects in Handeni. This means that hay making is not common.

Crop residues: maize, beans and cow peas are major sources of crop residues for farmers in the district. Rice straw is utilised to some extent but, currently, the majority of the straw is either burned or left to rot in the field.

Concentrates: some processing by-products are sold by the agro-dealers (e.g. maize bran and sunflower cake) alongside commercial processed feed from outside the district (e.g. cotton seed

cake, rice bran and molasses). These external feed inputs are sourced from Dar es Salaam, Moshi, Iringa and Tanga. Molasses comes from the Mvomero and Kilosa districts. Inputs from Arusha may originate in Kenya. A few farmers combine a range of concentrates to make their own formulations.

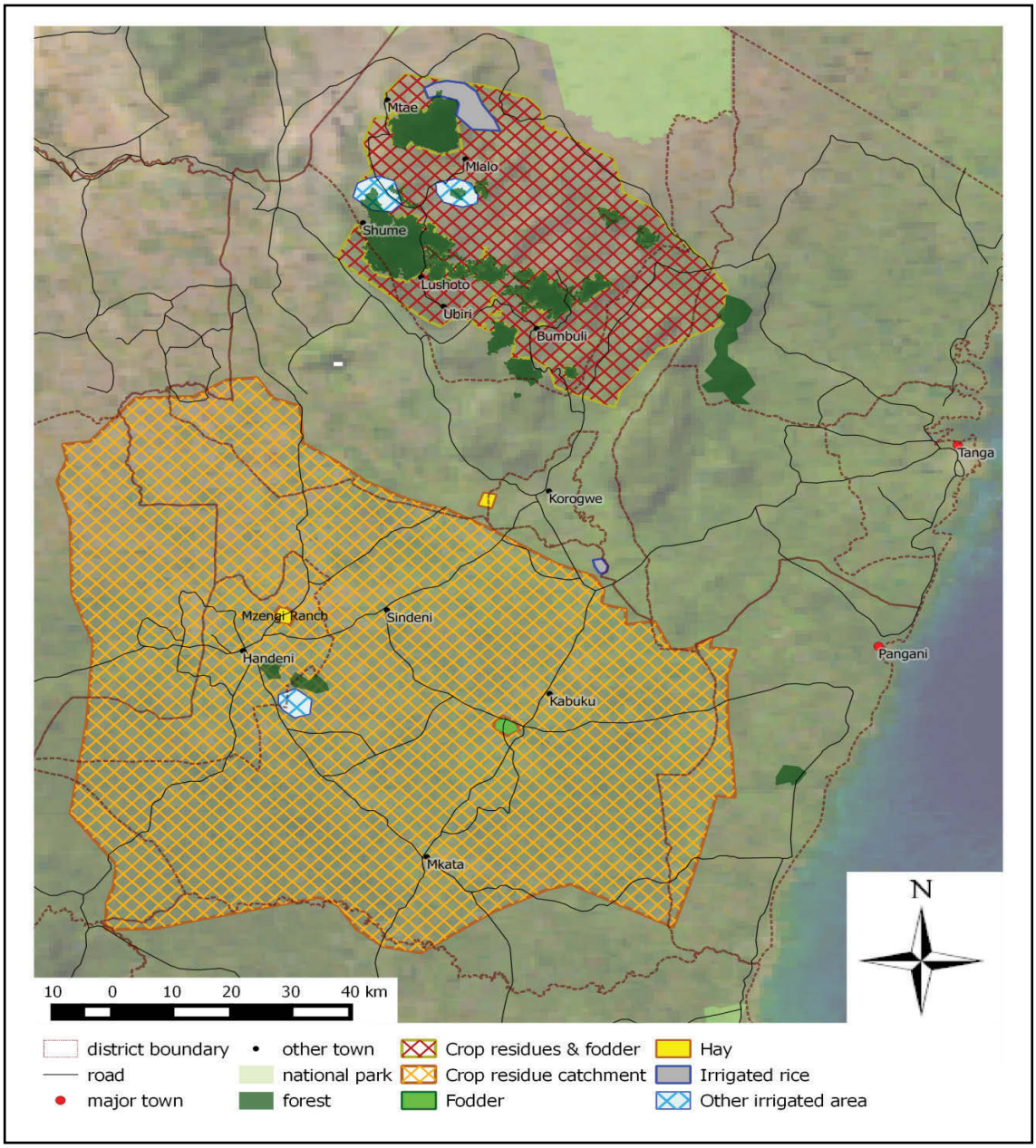

Figure 7: Location of feed types and sources for dairy livestock

Source: expert consultation discussions and PGIS maps, June 2014.

Note: Blank areas on the map indicate 'no data' rather than 'no dairy-related activities'.

2.3 Environmental resources: status and risks

Land quality

It was agreed that land for grazing or growing feed, and space for keeping livestock were the most important resources for dairy farming, followed by water. Land quantity was thought to have a greater influence on dairy systems than land quality. In the Lushoto highlands, for example, where

growing conditions are more suited to intensive dairy production, it is the lack of available land that is the predominant reason for the existence zero and semi-zero grazing systems. In Handeni, it was noted that land is plentiful, which has attracted migrant farmers from neighbouring regions such as Arusha.

Risks to land quality

Farming on the steep slopes in Lushoto was said to pose a risk of soil erosion, for example at Ubiri, Kwemashai, Mbuzii and Soni, and this could affect important rivers with sedimentation. However, in most parts of Lushoto the situation was felt to have improved (Mlalo and Mtae were given as examples) because of the long-term promotion of soil conservation measures such as terraces, *fanya juu* and contour planting. A district-wide terrace building initiative was implemented through the District Agriculture office by the Soil Erosion Control and Afforestation Project (SECAP) in 1984. One of the few areas identified that still gives cause for concern is in Ubiri (Figure 8). Soil retention was also said to be aided by planting fodder grasses and trees on the contours and around perimeters of fields.

In Handeni, participants noted that overgrazing and trampling have caused compaction and soil degradation, particularly for a radius of about 0.5 km around water points. Specific areas were identified in Handeni, where environmental degradation from livestock keeping is noticeable (Sindeni, Magamba and Mzundu areas). On the other hand, the extensive use of manure in Lushoto is seen as maintaining soil fertility in the fields.

Blackjack (*Bidens pilosa*), which is used as a vegetable when young, was recognised as sign of fertility. *Kidente* is used in Handeni to indicate low fertility.

Vegetation

Linked to land resources, vegetation was identified as a key resource as it provides feed and other ecosystem services. In Soni and Ubiri/Kwemashai in Lushoto, participants expressed concern about deforestation, but it was not established whether this was related to livestock keeping. Forests were said to be essential as they influence precipitation patterns. Burning to clear fields, instead of ploughing, was seen as a problem in some parts of Lushoto (around Mbuzii). This was also the case with some forests in the district (Figure 8). Burning was also agreed to be prevalent across a large part of Handeni district.

Certain parts of Lushoto were highlighted where vegetation does not last throughout the dry season, leading to fodder shortages. In response, participants noted that growing drought-resistant fodder varieties would be beneficial, in particular varieties that are deep-rooted and will not be uprooted by grazing.

Water resources

It was also agreed that water is a vital resource for livestock keeping, for the production of feed and for drinking water. In Lushoto, participants noted that most households had access to piped water or wells, and that the rainfall is high enough to provide water for most of the year. In Handeni, participants noted that most rivers are seasonal and identified small reservoirs (‘charco dams’) and a few springs as additional water sources (Figure 8).

Participants recounted how the government has built 39 dams across Handeni in the past 10 years to improve dry season water availability for livestock. Except in multi-year drought periods, there is sufficient water to last through the dry season. However, herders still can spend a significant amount of time searching for water. It was noted that the water quality in the dams is maintained

by keeping livestock away from the water body. A water pipe extends below the dam wall to a drinking trough where livestock can drink. If the reservoirs dry out, water points were identified that provide water from the Korogwe main pipeline. Livestock keepers and domestic users can access these for a small fee. Furthermore, it was noted that the government has plans to provide one charco dam for each settlement in Handeni district.

Farmers were also known to be engaged in water management. For example, in a forest near Sindeni, participants gave an example of a spring, known as Kibaya, that was under threat. It was an open spring with no proper management, but the area was fenced by locals to protect it from pollution and safeguard it. Animals can now drink without stepping up to it directly, as an area has been set aside for both livestock and people.

Important rivers identified in Handeni were the: Pangani, Bumburi, Msangazi and Mnyusi. All were described as cold and saline. Important rivers identified in Lushoto were the: Soni (with its source in Mkuzi, which eventually joins the Mombo) and the seasonal rivers Mkuzu and Mnolo.

In Handeni, both the drilled borehole water and the water piped from Korogwe were said to be salty and in need of treatment before it is good for human consumption. Rainwater was said to be available to buy but more expensive. It was noted, however, that livestock prefer the salty water to rainwater because of the mineral content; and that seasonal rivers are generally saltier than permanent ones. There were several points mentioned (but not mapped) where rivers pass salty deposits – and these are known to be preferred by farmers as watering points.

Noted sources of pollution of the rivers include: erosion, leading to siltation of the dams – which was mentioned as a good thing because it seals the dams so they hold water for longer; and pesticides from farming the river banks. It was also noted that if cattle are allowed out to graze while they are still wet after being dipped or sprayed, the chemicals can drip and enter the river (although only in trace amounts so this is not considered a problem). The main source of river pollution is waste from human settlements.

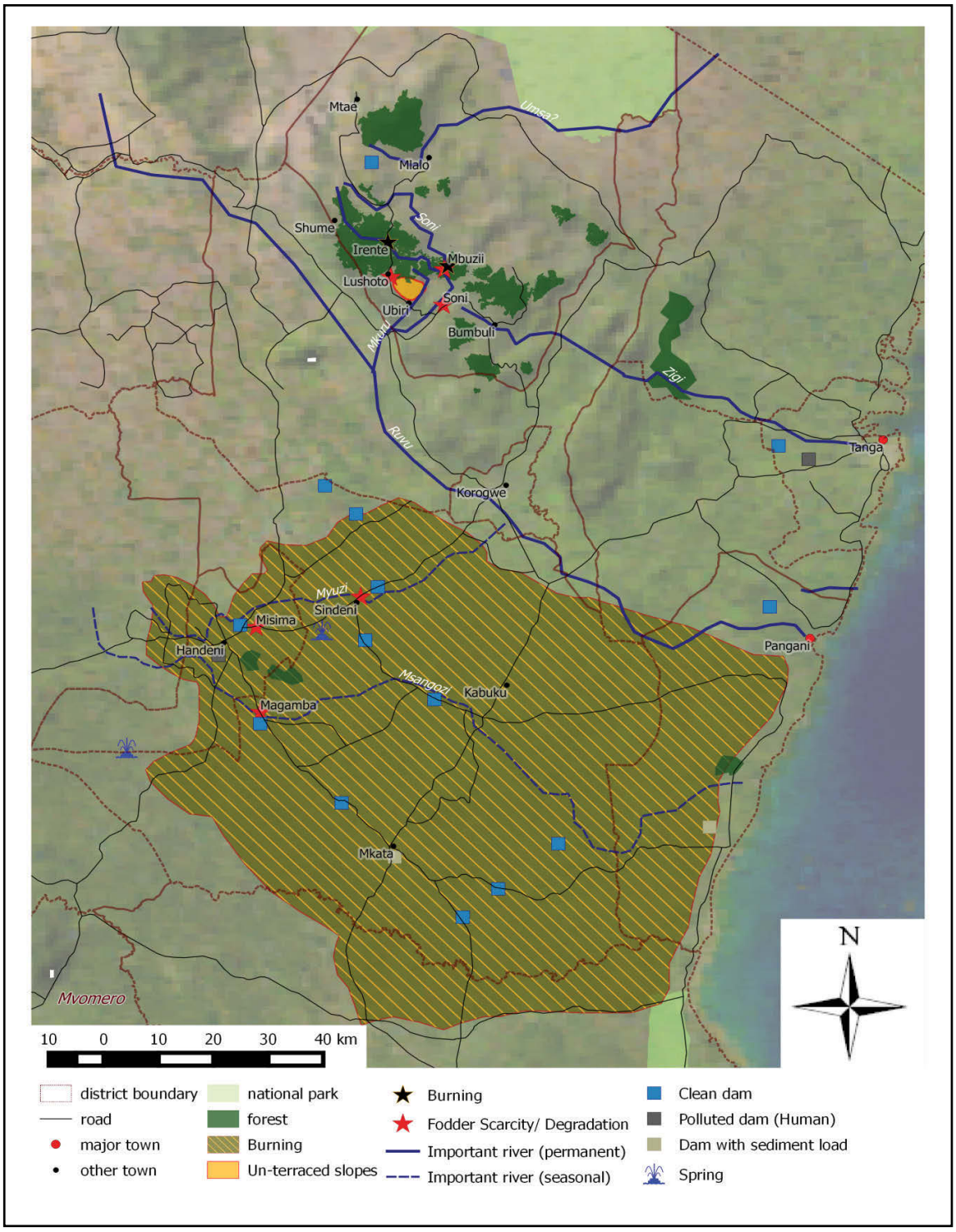

Figure 8: Environmental resources and issues highlighted in the workshops

Source: expert consultation discussions and PGIS maps, June 2014.

Note: Blank areas on the map indicate 'no data' rather than 'no dairy-related activities'.

2.4 Scenarios for smallholder dairy development

On the second day, each group was given a target for increasing milk production and asked to develop scenarios for how to achieve the target. The targets discussed were:

A. To stabilise milk production at the same level all year round without forest conversion; and

B. To improve the average output per cow from 1–2 litres per day to 5–8 litres per day in extensive systems, or from 4–8 litres per day to 10–15 litres per day in semi-intensive systems.

Scenario discussions revolved around: (i) **improving feed quantity and variety** – to provide more or better feed to improve milk yields, and/or to provide more feed in the dry season to sustain milk yields throughout the year; (ii) **improving animal breeds** for higher productivity; and (iii) **improving support services** and infrastructure. The results are described in Box 1 and Figure 9.

Box 1: Strategies to increase and stabilise milk production year round

1. Improve feed production, conservation and feeding practices

- *Grow better varieties of fodder*, such as high yielding, drought resistant varieties
- *Conserve fodder by making hay*: increase growing areas, commercialise it and provide training on the best methods of making and preserving hay (against damp in Lushoto and termites in Handeni)
- *Store farm crop residues*: provide training on the best methods of preparing and preserving the residues
- *Incorporate different feeds and concentrates*: e.g. increased use of rice cake and sunflower cake; make information available on the best ratios and when and/or how to use supplements
- *Better land use planning:* to balance demand for food and fodder in Lushoto, and increase production in Handeni; plant more fodder crops in contours and on terraces, devote sections of land to fodder; encourage ranching, with a group of farmers dedicating land to semi-intensive dairy and fodder production;
- *Irrigation for growing fodder year-round*: expand current irrigation areas for fodder crops, or expand rice-growing to produce more residues; encourage rainwater harvesting for local dry season irrigation
- *Improve grazing areas*: by growing different types of feed
- *Import additional feed*: from Arusha and Iringa, and molasses from Morogoro
- *Offer education* on livestock keeping that considers the stocking rate (the number of livestock depending on the available area).

2. Improve the animal breeds from current cattle breeds (low yielding) and find breeds of cattle that produce a lot of milk.

- *Selective breeding using better bulls and/or using more artificial insemination*
- *Start farms* for breeding heifers
- *Offer education* on better livestock keeping methods

3. Improve livestock infrastructure and extension services

(Kuboresha miundo mbinu ya mifugo na huduma za ugani)

- Dig more *water pans/dams* for livestock
- *Provide more animal health centres*
- *Increase the number of cattle dips* and/or the availability of spray equipment and medicines
- *Build cattle sheds*
- *Increase the market* for milk and other products, including *more milk collection centres*
- Increase the *number of extension officers*
- *Promote dairy* as an economic activity, not for subsistence

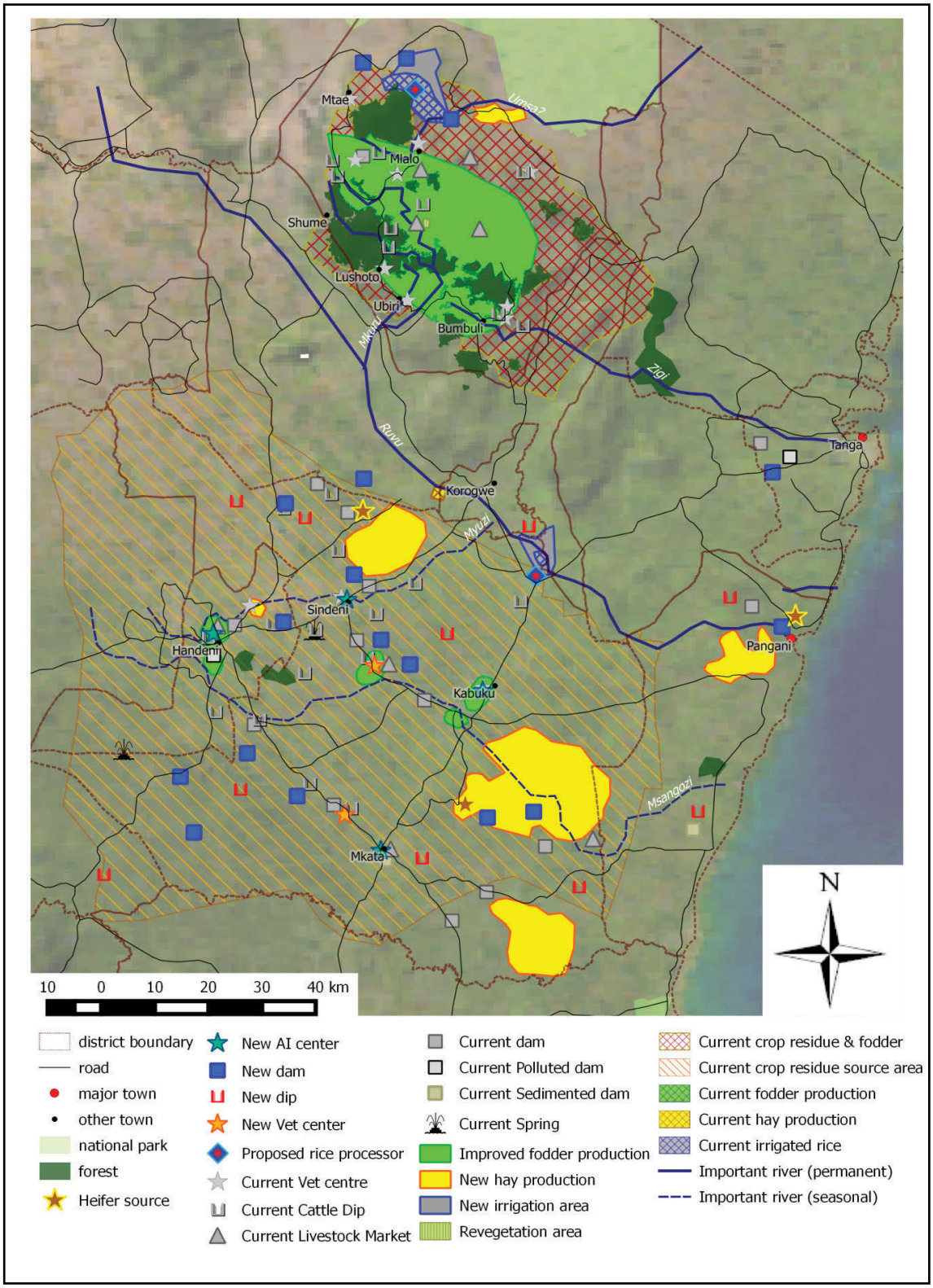

Figure 9: Spatially explicit changes described in the scenario discussions

Source: expert consultation discussions and PGIS maps, June 2014.

Note: Blank areas on the map indicate 'no data' rather than 'no dairy-related activities'.

3. PARTICIPANTS' REFLECTIONS

Participants were keen to be involved in the process. The mapping exercise provided an opportunity to develop an authoritative resource on the location of attributes across the district. Participants reflected that this could be useful in their work, for explaining to others and developing proposals. The participants therefore asked for a report on the workshop process, and for the results to be published in English and Swahili for this purpose. This report is in answer to their request. Furthermore, participants were eager to see future activities build on this PGIS workshop and use this activity to deliver benefits to farmers in the region.

To improve the process in future, participants commented on the distractions arising from the inaccurate mapping of village and road locations.

4. CONCLUSIONS

The dairy production systems, infrastructure and environmental baseline in Lushoto and Handeni districts were discussed and mapped using a participatory GIS process. The primary aims of undertaking these activities were to identify the environmental impacts of the changes required in order to increase milk yields, and to contribute context-specific data to the proof-of-concept ex-ante environmental assessment framework, CLEANED. The secondary aims of conducting this mapping exercise were to provide an opportunity for dairy industry proponents to think through the industry's needs in the future and provide a resource that can be built on and communicated with. The results of this report relate to the data collected, which can be used for these purposes.

The process also ascertained which changes would need to take place across the districts in order to realise the ambition of Maziwa Zaidi, which is to reduce poverty and vulnerability among dairy-dependent livelihoods in selected rural areas in Tanzania by enabling rural dairy farmers to secure more income through enhanced access to demand-led dairy market business services and viable organizational options.

Extensive, semi-intensive, intensive and ranching dairy production systems were identified across the Lushoto and Handeni districts. Lushoto has predominantly intensive production, whereas Handeni is dominated by extensive production. Dairy-related infrastructure was located in the districts, including milk collection centres, milk processors, veterinary centres, agricultural extension services, cattle dips and livestock markets. The feed resources that these dairy producers rely on were mapped, consisting of pastures, various crop residues and legumes. Supplements and concentrates including molasses were more commonly sourced from outside the districts. Interactions with environmental resources in the area were quite complex. Access to water in the dry season, environmental degradation from trampling and overgrazing, and irresponsible burning are particular concerns.

Workshop participants assessed the scenario for increasing milk yields from 1–2 litres per day to 5–8 litres per day in extensive systems, and from 4–8 litres per day to 10–15 litres per day in more intensive systems. Improving feed resources was highlighted as a primary action, in terms of quality, quantity and fodder preservation, along with support interventions such as herd management and breeding, and strengthening the extension support and dairy marketing chains.

Overall, the overview of smallholder dairy livestock keeping, fodder production and the environmental context built during the workshops suggests that the smallholder dairy industry is still in its early stages of development, and that the impact on the environment that can be directly attributed to dairy production is not as yet a cause for concern locally. The discussions on the scenarios for dairy sector development suggest that much of the increase in milk yield could be brought about through education on improving production efficiency by using currently available resources more effectively, rather than by using more resources.

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APPENDIX: AGENDA

Agenda Day 1: Lushoto (This is the planned agenda, not the revised agenda based on going over time)	
09:00–09:30	Registration and Introduction
09:30–10:30	Discussion and mapping: Dairy farming distribution
10:30–10:45	–TEA–
10:45–12:30	Discussion and mapping: Feed sources and production
12:30–13:00	Plenary discussion
13:00–13:50	–LUNCH–
13:50–14:00	Recap and energiser
14:00–15:00	Discussion and mapping: Environmental resources
15:00–16:00	Plenary discussion
16:00–16:15	–TEA—
16:15–16:30	Wrap up

Agenda Day 2: Lushoto	
09:00–09:30	Arrival and welcome
09:30–10:30	Introduction, recap of Day 1; Introduction to scenarios
10:30–11:00	–TEA–
11:00–12:30	Discuss, develop scenario in groups
12:30–13:00	Plenary discussion
13:00–13:50	–LUNCH–
13:50–14:00	Recap and energiser
14:00–15:00	Scenario 2 (*note the first scenario took longer than expected, so this slot was used for the Plenary session discussion instead*)
15:00–15:30	Wrap up

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